Paper Submission

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Abstract

This paper considers such kinds of markets: one side "sells his ability" to the other side, but the ability is hard to be quantified precisely. One specific example is paper submission. Without precise perceptions of quality, how to submit a paper to a journal is a strategic task for authors, and whether to accept a seemingly good paper is also difficult for editors. I build a model to study these tasks. I find that, in equilibrium, the author adjusts her strategy through learning, and the editor corrects selection bias by raising the threshold of acceptance. Furthermore, I find that even without the cost of entry, there exist entry barriers in such markets.

JEL classification: C72, D83, L13

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1. Introduction

With many journals in the field, it is a strategic task for authors that to which one she should submit her paper. High-standard journals bring a higher payoff from publication, but the possibility of acceptance is low. On the other hand, submitting to a low-standard one is a secure choice, but the payoff is low. The task becomes tougher when authors do not have precise perceptions of the quality of their papers. From the journals' side, they only publish papers of good quality. Once an editor receives a seemingly good one, he worries about overvaluation since the paper might have been rejected by other journals before. In other words, it is implied that receiving a paper is not good news. In this article, I build a model to characterize agents' behavior: how an author decides submission order, how she learns the quality of her paper from each rejection, and how journals correct selection bias.

Consider an author who writes a paper of unknown quality. The quality depends on her type, which is her private information. Assume that a high-type author is more likely to write a paper of good quality. She can submit her paper to a journal at some cost. Getting rejected, she can try another one. Journals publish a paper only when the quality is higher than some standard. The editor can not precisely know the quality but can observe a noisy signal. A high-quality paper is more likely to generate a good signal.

If journals are homogeneous, a low-type author knows that her paper is unlikely to be accepted. Therefore, only when the author's type is high enough, she submits her paper to a journal randomly selected. Getting rejected, she learns that her paper may not be of high quality and wonders whether it is worthwhile for another try. Only those with relatively higher types continue. The process goes on until either the author finds it better to stop or she tries all journals. The editor realizes that the paper he receives might have been rejected. He corrects this selection bias by only accepting papers with better signals.

If journals are heterogeneous, the market splits. A high-type author targets top-class journals publishing good-quality papers because it brings a high payoff. A low-type author has an alternative, the ordinary journals with lower standards, because they have lower thresholds of signals and bring a higher probability of acceptance. Due to this separation, top-class journals receive papers of higher average quality. Thus, they set a lower threshold of signals compared to the homogeneous case. It lets them publish more good-quality papers. Diversity is beneficial to efficiency.

However, if the difference (the standards of the quality, the payoffs from publication) between a top-class journal and an ordinary one is not that large, a counterintuitive equilibrium could also exist. The ordinary journal with a lower standard of quality sets a higher threshold than the top-class one. More precisely, in this case, the top-class journal is the author's first option. The ordinary journal only receives papers having been rejected and perceives that the quality is more likely to be bad, which causes the inverted thresholds of acceptance.

Which equilibrium is selected depends on which journal exists at first. It is a trigger for the existence of entry barriers in such markets, even without the cost of entry. If the top-class journal (incumbent) exists before the ordinary journal (entrant), authors take the incumbent as the first option. Then, the entrant is not able to undercut the incumbent by setting a slightly lower standard of quality since as reasoned above, the entrant must set a higher threshold even though its standard is lower. If the entrant tries to compete by setting a higher standard, it needs to set an unfairly high threshold to select qualified papers among those rejected by the incumbent. It makes the amount of publication low. In summary, the convention of submission order generates the inverted thresholds while the latter intensifies the former.

The key factor to generate this vicious cycle is the information asymmetry between authors and journals. It stems from their noisy perceptions of quality and journals' ignorance about authors' submission histories. The entry barrier disappears when journals know the quality perfectly because now authors' histories are irrelevant and thus the information asymmetry does not exist. On the other side, it becomes weaker when authors know the quality perfectly. Setting a high standard of quality, the entrant becomes the first option for authors with good-quality papers as long as it brings a higher payoff. Even though the standard is relatively higher, they are sure that their papers can pass the refereeing. That is to say, the entrant captures the top part of the market. In contrast, if authors just have a rough perception of quality, the entrant loses top authors because they are not sure of acceptance. They turn to the incumbent, and the entrant receives bad-quality papers mostly.

These findings provide insight into the formation of oligopolies in such markets: one side "sells his ability" to the other side, but the ability is hard to be quantified precisely. Thus, the analysis in this paper can have broader applications to markets like top clubs in a sports league (seller: juvenile players, buyer: Real Madrid and Barcelona), school admissions (seller: students, buyer: top tier universities), or even the market of artists like record labels' oligopoly (seller: musicians, buyer: Universal, Sony, and Warner).

The rest of the article is organized as follows. Section 2 presents the model. Section 3 characterizes the equilibrium. Section 4 analyzes the case with heterogeneous journals and shows the possibility of multiple equilibria. Section 5 discusses the existence of entry barrier. Section 6 concludes and gives further discussion.

1.1. *Related Literature*

This paper contributes to the literature of academic publishing with information asymmetry. One contribution is the analysis of the agents' learning process. The other one is the existence of an entry barrier in such markets.

Several existing papers of academic publishing have a similar model structure, Cotton [2013], Leslie [2005], Muller-Itten [2017], Ellison [2002] and Azar [2015]. Among them, Cotton [2013], Leslie [2005] and Ellison [2002] focus on the necessity of the submission fee and the lengthy refereeing. A similar result is found in this paper that journals have the incentive to set some cost to screen those high-type authors. Muller-Itten [2017] puts more emphasis on the author's behavior. It defines a score system where the author's ranking of submission is based on a score including some factors like the quality of the paper, the difficulty of publication, etc. This idea could be traced back to Oster [1980]. Heintzelman and Nocetti [2009] uses the score system to analyze the case that the journal could precisely perceive the quality. Azar [2015] presents a simple model with one author and one journal. It characterizes the agents' behavior and analyzes how it changes with submission cost, journals' standards, and the noise in the editor's signal. The information structure used in the model is similar to the one in Zhu [2012] and Lauermann and Wolinsky [2016]. They present the search model where the side with information disadvantage is sampled and receives noisy signals about the state.

In regard to the equilibrium multiplicity, many papers (Cooper and John [1988] and Milgrom and Roberts [1990]) attribute it to strategic complementarities. Brock and Durlauf [2001] presents a random field model that the agents are influenced by their neighbors' behavior, which follows the same intuition as above two. In this paper, the equilibrium multiplicity comes from the convention of the authors' submission order and journals' noisy perception of quality. I also use the mutation method introduced in Kandori et al. [1993] and Young [1993] to see which equilibrium is selected in the long run.

There is little literature discussing the formation of entry barrier under information asymmetry. Dell'Ariccia et al. [1999], Dell'Ariccia [2001] and Marquez [2002] present a model of the banking industry where the incumbent has the information advantage over the entrants. Thus, the latter face the adverse selection problem because they can not know whether the borrower has been rejected by the incumbent.

2. The Model

Consider that an author writes a paper of an unknown quality $q \in \mathbb{R}$. The quality q is contingent on her type $\theta \in \mathbb{R}$, which is her private information. The probability distribution of the quality conditional on the type follows a continuous density function $f(q|\theta)$, and I assume that f satisfies the monotone likelihood ratio property (MLRP). It means that a high-type author is more likely to write a paper of higher quality. Let the continuous function $\mu(\theta)$ be the prior distribution of the author's type.

Assume that there are m class-A journals. A publication in one of them yields a payoff $v > 1$ to the author. In each round, the author can submit her paper to a journal with a submission cost $c < 1$. Getting rejected, she can choose another journal in the next round, or stop trying.

From the journals' side, they only want to publish a paper of sufficiently high quality. Specifically, the journal's payoff of publishing a paper with quality q is $q - q_A$. They publish a paper if and only if the quality is higher than q_A. The journal can not precisely know the quality but can observe a noisy signal $s = q + \epsilon$, $\epsilon \sim \mathcal{N}(0, \sigma_s^2)$.

Importantly, the author keeps a record of historical submission failure but the selected journal does not know. Let $h \in H = \{\emptyset, (A), (A, A), ...\}$ be the set of all possible history. For example, $h = (A, A)$ means that the author submitted her paper to two journals of class-A in the first and second rounds and got rejected. For simplification, denote A^i as the history where the author tries i times but all fails.

Strategy

The strategy of the author is a mapping from her type θ and her history h to either submitting her paper to a class-A journal or stopping, $\tau : \mathbb{R} \times H \to \{A, stop\}$. The strategy of the journal is a mapping from the signal s to either accepting or rejecting, $\eta_A : s \to \{Accept, Reject\}$.

Belief

From the author's side, given the history h, she gets a posterior distribution of the quality $f(q|\theta, h)$ by applying Bayes' rule. For instance, if $h = (A)$, then

$$f(q|\theta, h) = \frac{f(q|\theta) \int \mathbb{1}_{\{\eta_A(s)=Re\}} \phi(s, q, \sigma_s) ds}{\int dq f(q|\theta) \int \mathbb{1}_{\{\eta_A(s)=Re\}} \phi(s, q, \sigma_s) ds}$$

where ϕ is the probability density function of a normal distribution.

Let $\mathcal{F}$ be the set of all possible posterior distribution $f(q|\theta, h)$. Receiving a paper, the editor of a class-A journal forms a belief of the distribution of the quality conditional on the author's history and her type. Equivalently, he forms a belief of the posterior distribution of the quality: $\beta_A : \mathcal{F} \to [0,1]$, where he believes the distribution of the quality is f with probability $\beta_A(f)$.

Equilibrium

I study the perfect Bayesian equilibrium of this game. A tuple (τ, η_A, β_A) is a perfect Bayesian equilibrium if

1. Given signal s and belief β_A, class-A journals accept a paper ($\eta_A(s) = Ac$) if and only if the expected quality is higher than q_A,

$$\sum_{f \in \mathcal{F}} \beta_A(f) \mathbb{E}_f[q|s] \geq q_A \tag{1}$$

2. Given her history h, the author calculates the expected payoff of submitting her paper to a class-A journal. That is,

$$\pi_A(\theta, h) = v \int f(q|\theta, h) \int \mathbb{1}_{\{\eta_A(s)=Ac\}} \phi(s, q, \sigma_s) ds dq - c \tag{2}$$

If $\pi_A(\theta, h) \geq 0$ and the author has not tried all journals, she submits her paper to a journal of class-A ($\tau(\theta, h) = A$) she has not tried before. Otherwise, she stops ($\tau(\theta, h) = stop$).

3. Given τ and η_A, $f(q|\theta, h)$ and $\beta_A(f)$ are derived through Bayes' rule.

2.1. Preliminary Observation

Journal's problem. Receiving a paper, the editor worries that it has been rejected by other journals before. In other words, receiving a paper is not good news. This selection bias effect should be considered when he forms the belief of the quality. In this paper, I consider the symmetric equilibrium, in which the author sets the submission order randomly. Thus, one journal's position in the order is uniformly distributed. Then, the editor forms a belief of the distribution of the quality

$$\beta_A(f(q|\theta, h = A^i)) = \frac{\mu(\theta) \cdot \mathbb{1}_{\{\tau(\theta, A^i)=A\}} \cdot Pr[h = A^i|\theta]}{\sum_{i=0}^{m-1} \int \mu(\theta) \cdot \mathbb{1}_{\{\tau(\theta, A^i)=A\}} \cdot Pr[h = A^i|\theta] d\theta} \tag{3}$$

To compute $Pr[h = A^i|\theta]$, one uses the following equations:

$$Pr[h = A^i|\theta] = Pr[h = A^{i-1}|\theta] \cdot \mathbb{1}_{\{\tau(\theta, A^{i-1})=A\}} \cdot \int f(q|\theta, A^{i-1}) \int \mathbb{1}_{\{\eta_A(s)=Re\}} \phi(s, q, \sigma_s) ds dq$$

and

$$\sum_{i=0}^{m-1} Pr[h = A^i|\theta] = 1$$

The first equation means, to transit from history A^{i-1} to A^i, the author first submits and then gets rejected.

Given his belief, the editor uses a cutoff strategy because the distribution of signal s satisfies MLRP.

Lemma 1. *There exists a threshold s_A such that the journal accepts a paper if it observes a signal $s \geq s_A$, and otherwise, it rejects.*

Proof: The left hand side of (1) is increasing and continuous in s. Moreover,

$$\lim_{s\to+\infty} \mathbb{E}_f[q|s] = +\infty, \ \lim_{s\to-\infty} \mathbb{E}_f[q|s] = -\infty, \ \forall f \in \mathcal{F}$$

Therefore, there exists a s_A such that

$$\sum_{f\in\mathcal{F}} \beta_A(f)\mathbb{E}_f[q|s_A] = q_A. \ \blacksquare$$

Author's problem. Before deciding to submit, the author first forms a belief of the quality based on her type and her submission history h, $f(q|\theta, h)$. It can be rewritten as follow given lemma 1,

$$f(q|\theta, h) = \frac{f(q|\theta)\Phi^i(s_A, q, \sigma_s)}{\int dq f(q|\theta)\Phi^i(s_A, q, \sigma_s)}, \ if \ h = A^i$$

where Φ is the cumulative distribution function of a normal distribution. Note that $f(q|\theta, h)$ also satisfies the MLRP.

Then, the author faces a trade-off between the gain from publication and the submission cost. She finds it optimal to submit if

$$v \int f(q|\theta, h)[1 - \Phi(s_A, q, \sigma_s)]dq \geq c$$

Obviously, as the author gets more rejections, she should know her paper is less likely to be of high quality. Thus, the gain (left hand side) will finally be lower than the cost. She should stop submitting. Moreover, the gain is increasing with the type because of MLRP. Thus, there is a sequence of types, $\theta_0 < \theta_1 < \theta_2 < ... < \theta_{m-1}$ where the authors with type $\theta < \theta_0$ never submits; those with type $\theta \in (\theta_0, \theta_1)$ submits only once; those with type $\theta \in (\theta_1, \theta_2)$ submits twice; so on and so forth.

Lemma 2. *Given* s_A*, for any history* h*, there exists a unique* $\theta^*_A(h) \in (-\infty, +\infty)$ *such that* $\pi_A(\theta^*_A(h), h) = 0$*. Not having tried all class-A journals, the author with history* h *submits her paper to a class-A journal if her type* $\theta \geq \theta^*_A(h)$*. She stops if her type* $\theta < \theta^*_A(h)$ *or* $h = A^m$*. Moreover,* $\theta^*_A(A^{m-1}) > ... > \theta^*_A(A) > \theta^*_A(\emptyset)$*.*

Proof: Since $f(q|\theta, h)$ satisfies the MLRP, $\pi_A(\theta, h)$ is monotonically increasing. Along with

$$\lim_{\theta \to +\infty} \pi_A(\theta, h) = v - c > 0, \lim_{\theta \to -\infty} \pi_A(\theta, h) = -c < 0, \forall h \in H$$

there exists a unique $\theta^*_A(h)$ such that $\pi_A(\theta^*_A(h), h) = 0$. Also, $\pi_A(\theta^*_A(h), h) \geq 0$ if $\theta \geq \theta^*_A(h)$. $\frac{f(q|\theta, A^{i+1})}{f(q|\theta, A^i)} \propto \Phi(s_A, q, \sigma_s)$ is decreasing in q. As a result, either $f(q|\theta, A^{i+1})$ is always lower than $f(q|\theta, A^i)$, or they are single crossing. Under both cases, $\pi_A(\theta, A^{i+1}) \geq \pi_A(\theta, A^i)$. Therefore, $\theta^*_A(A^{m-1}) > ... > \theta^*_A(A) > \theta^*_A(\emptyset)$. ■

3. Equilibrium Characterization

In this section, I characterize the equilibrium of this model. First, I find that a unique symmetric equilibrium exists. Then, I analyze how the agents' behavior changes with the number of journals, the author's benefit-cost ratio, and the diminishing noise in agents' perception.

Proposition 1. *A unique symmetric equilibrium exists. The journals' threshold is* s^*_A*. The author with history* A^i *(*$i = 0, 1, ..., m-1$*) submits her paper to a journal randomly selected from those she has not tried yet if and only if her type* $\theta > \theta^*_A(A^i)$*.*

Proof: According to lemma 2, given s_A, $\theta^*_A(h)$ are well-defined and continuous in s_A since π_A is continuous in s_A. Then, the journal receiving a paper forms a belief β_A based on (3). According to lemma 1, the journal could find the optimal threshold noted as $\xi(s_A)$. The left hand side of (1) and β_A are continuous in $\theta^*_A(h)$. Therefore, $\xi(s_A)$ is continuous in s_A. Obviously, $\xi(s_A)$ is bounded. As a result, there exists a fixed point $\xi(s^*_A) = s^*_A$ according to Brouwer fixed-point theorem.

Secondly, as s_A increases, $\pi^*_A(\theta, h)$ decreases, which follows the fact that as the threshold gets higher, the paper is harder to be accepted and the expected payoff from submission is lower. Then. $\theta^*_A(h)$ increases, meaning that only high-type authors find it optimal to submit. Therefore, $\xi(s_A)$ decreases because the journal is more likely to receive a high-quality paper from high-type author. Thus, the equilibrium is unique since $\xi(s_A)$ is a decreasing function. ■

3.1. The Number of Journals

As the number of journals increases, two effects influence the agents' behavior. First, it decreases the probability that one journal is on the top positions of the author's submission order. Thus, the submitted paper could have been rejected many times before. That is to say, the quality is less likely to be high. To correct this selection bias, journals should raise their threshold.

Secondly, from the author's side, only the relatively higher-type one is willing to resubmit after getting rejected. It increases the average quality of the paper submitted and makes journals set a lower threshold. However, this effect dominates only when submission cost is extremely high.

Proposition 2. *There is* $\underline{c} \in (0, v]$ *such that if* $c < \underline{c}$*,* s_A^* *is increasing in* m*, and* $\theta_A^*(h)$ *is increasing in* m *for any* $h \in H$*.*

Proof: refer to Appendix D. ||

Example 1. *Consider a case where the author's type* θ *follows a normal distribution:* $\mu(\theta) = \phi(\theta, 0, \sigma_\theta)$*. The quality conditional on the type follows a normal distribution:* $f(q|\theta) = \phi(q, \theta, \sigma_q)$*.*

In figure 1, the upper two graphs show that both s_A^* *and* θ_A^* *increase as the number of journals increases. Moreover, they converge to some value. It is somewhat counterintuitive because as the number of journals gets extremely big, the probability that one journal is selected is very small. Therefore, being selected is very bad news: the author should have tried and failed many times before. It should make journals set an infinitely high threshold.*

For most authors, after getting rejected for several rounds, their beliefs of the quality have been passive enough. They find that the payoff from resubmitting is lower than submission cost. Therefore, once the journal receives a paper, it knows the author could not have been rejected for infinite times. That is the reason for convergence. In contrast, if one lets submission cost approach 0, s_A^* *and* θ_A^* *do not have any convergence, which is shown in the bottom two graphs in figure 1.* □

Example 2. *(Submission cost extremely high)*

Consider the case similar to example 1. The parameters are: $\sigma_\theta = 2$*;* $\sigma_q = \sigma_s = 1$*;* $q_A = 0$*;* $v = 2$ *and* $c = 1.9$*.*

If $m = 1$, $s_A^* = -1.4072833$*. If* $m = 2$, $s_A^* = -1.4072835$*. With extremely high submission cost, the threshold of signals can decrease as the number of journals increases.*

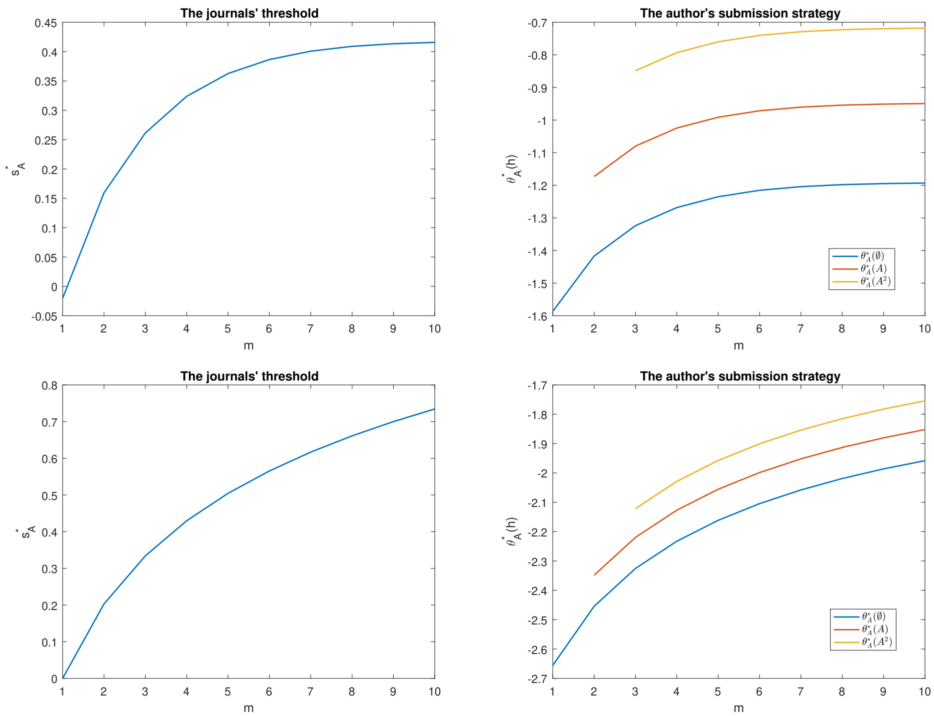

Fig. 1. The upper-left graph is journals' strategy s_A^* under different numbers of journals. The upper-right graph is the author's strategy $\theta_A^*(h)$. The parameters are: $\sigma_\theta = \sigma_q = \sigma_s = 1$; $q_A = 0$; $v = 2$ and $c = 0.2$. The bottom two graphs assume $c = 0.001$.

3.2. The Ratio v/c

As the value from publication increases compared to the cost, it leads the author with lower type to try or try again. Under this case, journals receive low-quality papers more often. Thus, they will increase their thresholds.

Proposition 3. *$\theta_A^*(h)$ is decreasing in v/c for any $h \in H$. s_A^* is increasing in v/c.*

Proof: refer to Appendix D. ||

Keeping the setting of example 1, figure 2 shows the trends of s_A^* and θ_A^* changing with different v/c. A higher submission cost discourages submission from low-type authors. It can be used as a tool to filter them. If journals form a coalition and set a positive submission cost cooperatively, they should let the expected quality of the marginal author's paper equal q_A.

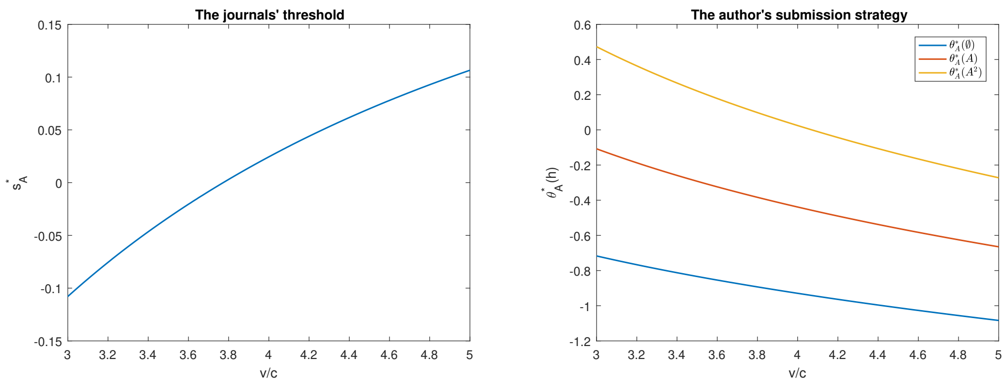

Fig. 2. The left graph is journals' strategy s^*_A under different v/c ratios. The right graph is the author's strategy θ^*_A. The parameters are: $\sigma_\theta = \sigma_q = \sigma_s = 1$; $q_A = 0$ and $m = 3$.

3.3. Author Knows the Quality

If the author knows the quality before submission ($f(q|\theta)$ is a delta function), then her problem reduces to whether

$$\pi_A(q, h) = v[1 - \Phi(s_A, q, \sigma_s)] - c > 0$$

She does not learn anything from rejection, and her payoff function does not depend on her history. If the quality is higher than some q^* making $v[1 - \Phi(s_A, q^*, \sigma_s)] = c$, then she always submits her paper until she gets a publication or there is no chance left. This feature is different from the finding in the previous case where the author has only a rough perception of quality. In appendix A, I analyze how the degree of this ignorance affects the agents' behavior in more detail.

From the journals' side, although they know the quality is at least q^*, it could be rejected before. In other words, selection bias still exists.

A preliminary result is q^* must be lower than q_A in the equilibrium. If it is not the case, the editor accepts the paper whatever signal it receives, knowing its quality is higher than the standard. Then, the author also submits the paper when the quality is lower than q^*.

Proposition 4. *A unique symmetric equilibrium exists, in which the threshold of the journal is s^*_A, and the author submits her paper to a journal randomly selected from those she has not tried yet if and only if its quality $q > q^*$, where $q^* < q_A$.*

Proof: refer to Appendix D. ||

3.4. Journal Observes the Quality Perfectly

Observing the quality perfectly ($s = q$ or $\sigma_s = 0$), the editor accepts a paper if $q > q_A$. In this case, there is no information asymmetry. Thus, after receiving the rejection, the author learns that her paper will not be accepted by another journal. Her problem reduces to

$$\pi_A(\theta) = v[1 - F(q_A|\theta)] - c > 0$$

θ' is the type that makes $\pi_A(\theta)$ equal 0. Then, only the author with the type $\theta > \theta'$ submits her paper. Once she gets rejected, she never submits again.

3.5. Asymmetric Equilibrium and Stability

In the previous analysis, I consider the symmetric equilibrium in which the author randomly chooses a journal. If she has a specific submission order, it may lead to an asymmetric equilibrium. The existence is not guaranteed, however.

For instance, there are two class-A journals: A1 and A2. The author always tries A1 at first, and then A2 after getting rejected. Importantly, in equilibrium, A2 should set a higher threshold than A1. If it is not the case, the author finds it better to submit to A2 at first. A2 has an incentive to do so since it receives papers rejected by A1. On the other hand, it has less incentive to do so because those low-type authors getting rejected stop trying. If the second effect dominates, the asymmetric equilibrium does not exist.

Example 3. *There are two class-A journals: A1 and A2. The author's type θ follows a normal distribution: $\mu(\theta) = \phi(\theta, 0, \sigma_\theta)$. The quality conditional on the type follows a normal distribution: $f(q|\theta) = \phi(q, \theta, \sigma_q)$. The parameters are: $\sigma_\theta = 0.5$, $\sigma_q = \sigma_s = 1$; $q_A = 3$; $v = 2$ and $c = 1.2$.*

We try to find the asymmetric equilibrium where the author does not randomly select the journal. If the author has a specific submission order: 'first A1 then A2', A1 sets a threshold of signal $s_1 = 2.78$, and the author with a type $\theta > 3.14$ submits to A1. Getting rejected, she submits to A2 when her type $\theta > 4.08$, and A2 sets a threshold $s_2 = 2.73$.

A2's threshold is lower than A1. The author has no incentive to submit A1 at first. Similarly, 'first A2 then A1' can not be an equilibrium. □

Note that when submission cost approaches 0, the second effect diminishes. Multiple equilibria exist. Section 4.2 and section 5 discuss the general situation in more details. Moreover, if asymmetric equilibria exist, the symmetric one is not stable. This is because if there is little difference between journals' thresholds, the journal with a low one becomes the first option for the author. In other words, there is a specific order of submission, which is the asymmetric equilibrium. However, it seems counterfactual because, in reality, not every author has the same order of submission.

One way to explain this paradox is to assume that the authors' payoffs are heterogeneous. Author i's payoff is v plus some subjective preference ϵ_i^j to journal j.

$$v_i^j = v + \epsilon_i^j,\ \epsilon_i^j \sim \mathcal{N}(0, \sigma_\epsilon^2)$$

Then, if we consider two journals A and B and their approximately close threshold s_A and s_B, author i submits to A at first if

$$(v + \epsilon_i^A) Pr[Accepted\ by\ A|s_A] > (v + \epsilon_i^B) Pr[Accepted\ by\ B|s_B]$$

$$\epsilon_i^A - \epsilon_i^B > \frac{v\big(Pr[Accepted\ by\ A|s_A] - Pr[Accepted\ by\ B|s_B]\big)}{Pr[Accepted\ by\ A|s_A]} =: k$$

The approximate probability that author i submits to A at first is $1 - \Phi(k, 0, 2\sigma_\epsilon^2)$. As long as the variance is sufficiently large to resist the perturbation of thresholds, the symmetric equilibrium is stable.

4. Competition

In this section, I introduce another class of journals having a lower standard compared to class-A journals. I characterize the agents' behavior and compare it with the previous case. Then, I find that there could be multiple equilibria. It triggers the idea of entry barriers in such markets.

4.1. Class-B Journals Exist

Now suppose there are infinitely many class-B journals besides class-A journals. The payoff from publication on a class-B journal is normalized to 1, and the submission cost is c. The other settings are similar as in the previous case. The payoff of publishing a paper with quality q for a class-B journals is $q - q_B$, $q_B < q_A$. Like class-A journals, they can not precisely know the quality but can observe a noisy signal $s = q + \epsilon$, $\epsilon \sim \mathcal{N}(0, \sigma^2)$.

In each round, the author can submit her paper to a journal of either class. If her paper is accepted and published, she gets the corresponding payoff. Otherwise, she can choose another journal to submit in the next round. I assume that the author wants to publish her paper as quickly as possible, which means her preference ranks as follow: publish in a class-A journal $\succ$ publish in a class-B journal $\succ$ rejected in this round and publish in a class-A journal in the next round $\succ$ rejected in this round and publish in a class-B journal in the next round $\succ$ ...

Let $\tilde{h} \in \tilde{H} = \{\emptyset, (A), (B), (A, A), (A, B), (B, B), ...\}$ be the set of possible history of the author's submission. For example, $\tilde{h} = (A, A, B)$ means that the author submitted her paper to two class-A journals in the first and second rounds and got rejected. In the third round, she submitted it to a class-B journal and got rejected. For simplification, denote $A^i B^j$ as the history that the author tries class-A journals i times and class-B journals j times but fails all.

Strategy

The strategy of the author is a mapping from her type θ and her history $\tilde{h}$ to either submitting her paper to A, to B, or stopping, $\tilde{\tau} : \mathbb{R} \times \tilde{H} \to \{A, B, stop\}$. The strategy of class-A journal is a mapping from the signal s it receives to either accepting or rejecting, $\tilde{\eta}_A : s \to \{Accept, Reject\}$. Similarly, $\tilde{\eta}_B : s \to \{Accept, Reject\}$.

Belief

Given the history $\tilde{h}$, the author forms a posterior distribution of the quality $f(q|\theta, \tilde{h})$ by applying Bayes' rule. Receiving a paper, the editor of a class-A journal forms a belief of the distribution of its quality $\tilde{\beta}_A : \mathcal{F} \to [0, 1]$, where the journal believes the distribution of the quality is f with probability $\tilde{\beta}_A(f)$. Similarly, denote $\tilde{\beta}_B$ as class-B journal's belief after receiving a paper.

Equilibrium

I use the perfect Bayesian equilibrium concept. A tuple $(\tilde{\tau}, \tilde{\eta}_A, \tilde{\eta}_B, \tilde{\beta}_A, \tilde{\beta}_B)$ is a perfect Bayesian equilibrium if

1. Given signal s and belief $\tilde{\beta}_A$, class-A journals accept the paper ($\tilde{\eta}_A(s) = Ac$) if and only if its expected quality is higher than q_A,

$$\sum_{f \in \mathcal{F}} \tilde{\beta}_A(f) \mathbb{E}_f[q|s] \geq q_A \tag{4}$$

   Given signal s and belief $\tilde{\beta}_B$, class-B journals accept the paper ($\tilde{\eta}_B(s) = Ac$) if and only if

$$\sum_{f \in \mathcal{F}} \tilde{\beta}_B(f) \mathbb{E}_f[q|s] \geq q_B \tag{5}$$

2. Given her history $\tilde{h}$, the author compares the expected payoff from submitting her

paper to a journal of either class. That is,

$$\pi_A(\theta, \tilde{h}) = v \int f(q|\theta, \tilde{h}) \int \mathbb{1}_{\{\tilde{\eta}_A(s)=Ac\}} \phi(s, q, \sigma_s) ds dq - c \tag{6}$$

and

$$\pi_B(\theta, \tilde{h}) = \int f(q|\theta, \tilde{h}) \int \mathbb{1}_{\{\tilde{\eta}_B(s)=Ac\}} \phi(s, q, \sigma_s) ds dq - c \tag{7}$$

If $\pi_A(\theta, \tilde{h}) \geq \max\{0, \pi_B(\theta, \tilde{h})\}$, then she submits her paper to a journal of class-A: $\tilde{\tau}(\theta, \tilde{h}) = A$. If $\pi_B(\theta, \tilde{h}) \geq \max\{0, \pi_A(\theta, \tilde{h})\}$, she submits it to one of class-B: $\tilde{\tau}(\theta, \tilde{h}) = B$. Otherwise, she stops: $\tilde{\tau}(\theta, \tilde{h}) = stop$.

3. Given $\tilde{\tau}$, $\tilde{\eta}_A$ and $\tilde{\eta}_B$, $\tilde{\beta}_A$ and $\tilde{\beta}_B$ are derived through Bayes' rule.

Journal's problem. Journals have the same problem as the previous case. Given their belief, class-A journals set a threshold of the signal s_A, and class-B journals set s_B.

Lemma 3. *There exists a s_A (s_B) such that the journal in class-A (B) accepts the paper if it observes a signal $s > s_A$ ($s > s_B$), and otherwise, it rejects.*

Proof: refer to Appendix D. ||

Author's problem. First, the author's posterior belief can be rewritten as

$$f(q|\theta, \tilde{h}) = \frac{f(q|\theta)\Phi(s_A, q, \sigma_s)\Phi(s_B, q, \sigma_s)}{\int dq f(q|\theta)\Phi(s_A, q, \sigma_s)\Phi(s_B, q, \sigma_s)}, \ if \ \tilde{h} = (A, B)$$

Then, the author faces three choices, submitting her paper to a class-A journal, to a class-B journal, or stopping. The expected payoff from submitting her paper to class-A (B) journals can be rewritten as

$$\pi_A(\theta, \tilde{h}) = v \int f(q|\theta, \tilde{h})[1 - \Phi(s_A, q, \sigma_s)] dq - c$$

and

$$\pi_B(\theta, \tilde{h}) = \int f(q|\theta, \tilde{h})[1 - \Phi(s_B, q, \sigma_s)] dq - c$$

The author compares the payoffs if they are positive. For a high-type author, she finds it optimal to submit her paper to a class-A journal because it could bring a higher payoff from publication. After getting several rejections, she perceives that the quality is less likely to be high. Thus, she either turns to a class-B journal if $\pi_B > 0$, or stops if $\pi_B < 0$. For a medium-type author, a class-B journal is the optimal choice, guaranteeing a relatively higher probability of acceptance. She continues until $\pi_B < 0$. For a low-type author, she finds it not optimal to try either class of journals.

Lemma 4. *Given s_A and s_B, for any history $\tilde{h}$, there exists a unique $\theta^*_A(\tilde{h}) \in (-\infty, +\infty)$ such that $\pi_A(\theta^*_A(\tilde{h}), \tilde{h}) = 0$; there exists a unique $\theta^*_B(\tilde{h}) \in (-\infty, +\infty)$ such that $\pi_B(\theta^*_B(\tilde{h}), \tilde{h}) = 0$; there exists a unique $\theta^*(\tilde{h}) \in [-\infty, +\infty)$ such that $\pi_A(\theta^*(\tilde{h}), \tilde{h}) = \pi_B(\theta^*(\tilde{h}), \tilde{h})$.*

If the author has not tried all class-A journals, then

- *if $\theta^*(\tilde{h}) > \theta^*_A(\tilde{h}) > \theta^*_B(\tilde{h})$, the author with history $\tilde{h}$ submits her paper to a class-A journal if her type $\theta \geq \theta^*(\tilde{h})$. She submits it to a class-B journal if her type $\theta \in [\theta^*_B(\tilde{h}), \theta^*(\tilde{h}))$. She stops if her type $\theta < \theta^*_B(\tilde{h})$.*
- *if $\theta^*(\tilde{h}) \leq \theta^*_A(\tilde{h}) \leq \theta^*_B(\tilde{h})$, the author with history $\tilde{h}$ submits her paper to a class-A journal if her type $\theta \geq \theta^*_A(\tilde{h})$. She stops if her type $\theta < \theta^*_A(\tilde{h})$.*

Otherwise, the author submits her paper to a class-B journal if her type $\theta \geq \theta^*_B(\tilde{h})$. She stops if her type $\theta < \theta^*_B(\tilde{h})$.

Proof: refer to Appendix D. ||

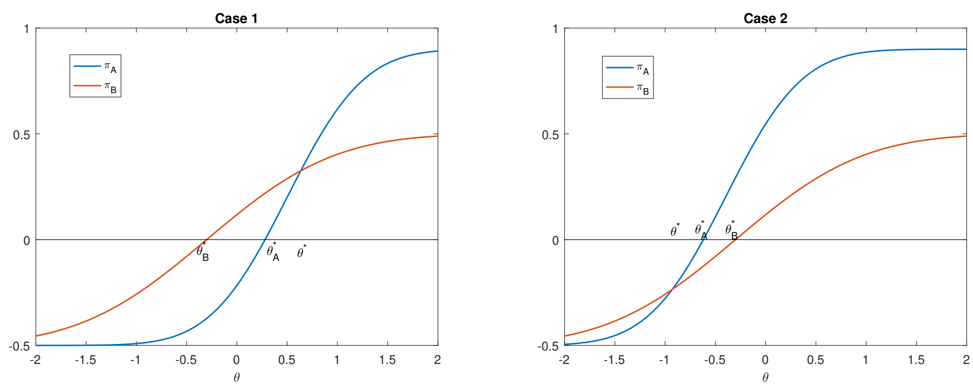

Fig. 3. Two cases of the order of $\theta^*(\tilde{h})$, $\theta^*_A(\tilde{h})$ and $\theta^*_B(\tilde{h})$.

These two lemmas characterize the agents' best responses. Moreover, one could find that $\theta^*(\tilde{h})$, $\theta^*_A(\tilde{h})$ and $\theta^*_B(\tilde{h})$ are continuous in s_A and s_B, and the best responses of journals s^*_A and s^*_B should be bounded. Therefore, an equilibrium exists.

Proposition 5. *An equilibrium exists where class-A (B) journals' threshold is s^*_A (s^*_B), and the author behaves in the way described in lemma 4.*

Proof: refer to Appendix D. ||

Remark 1: class-A journals' threshold

Compared to the case in the previous section, class-A journals receive papers from the higher-type author because now the low-type author has an alternative, class-B journals. Therefore, class-A journals set a lower threshold because the quality is more likely to be high ex ante.

Example 4. *Consider there is one class-A journal and other settings keep the same as in the example 1. In the left graph of figure 4, the blue curve represents the threshold of the journal* s_A^* *under different standards* q_A*. In the right graph, the blue curve represents the author's strategy* θ^**. She submits her paper to class-A journal if and only if her type* $\theta > \theta^*$*. Then, if we introduce class-B journals, the red curve in the left graph represents* s_A^**. In the right graph, if the author's type is above the red curve, she submits her paper to class-A journal. Otherwise, she either chooses a class-B journal, or she stops.*

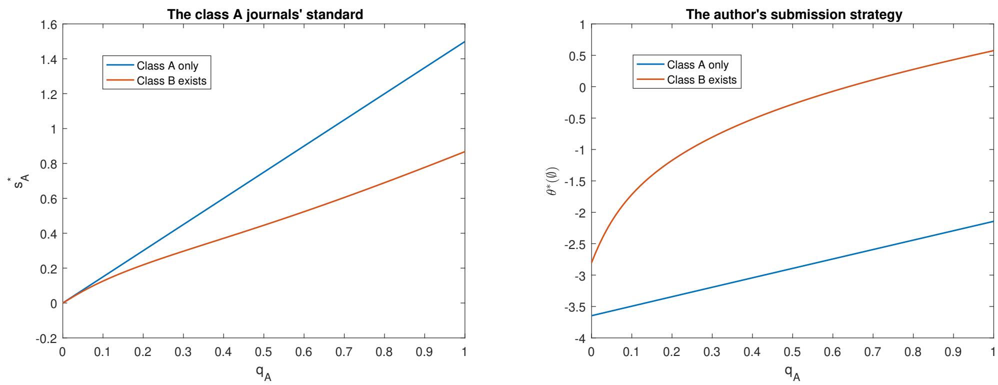

Fig. 4. The left graph is journals' strategy s_A^*. The right graph is the author's strategy $\theta^*(\emptyset)$. If her type θ is higher than $\theta^*(\emptyset)$, she submits her paper to class-A journal. The parameters are: $\sigma_\theta = \sigma_q = \sigma_s = 1$; $q_B = -1$; $v = 2$ and $c = 0.01$.

In the right graph, the red curve is above the blue one. It means that with the existence of class-B journals, the author with a lower type will submit her paper to them instead of class-A journal. The left graph shows that class-A journal's threshold s_A^* *is lower because the author's type is higher.* □

Introducing class-B journals makes high-type author's paper easier to be accepted by class-A journals. In appendix B, I analyze how this diversity affects market efficiency in more detail. I find that journals publish more papers, and good-quality papers are easier to be published.

Remark 2: Author's patience

In the above analysis, I assume that the author wants to publish her paper as quickly as possible. In contrast, not hurrying to publish her paper, she will try more class-A journals before switching to class-B journals. Let δ be the discount factor. An author with type θ and history $\tilde{h}$ finds it optimal to submit her paper to a class-A journal instead of a class-B one if

$$vPr[s > s_A|\theta, \tilde{h}] + \delta u(\tilde{h}A)(1 - Pr[s > s_A|\theta, \tilde{h}]) > Pr[s > s_B|\theta, \tilde{h}] + \delta u(\tilde{h}B)(1 - Pr[s > s_B|\theta, \tilde{h}])$$

where $u(\tilde{h}A)$ is the valuation function if the author's history becomes $\tilde{h}A$. Obviously, $u(\tilde{h}A) > u(\tilde{h}B)$ and $Pr[s > s_A|\theta, \tilde{h}] < Pr[s > s_B|\theta, \tilde{h}]$. Therefore, if an extremely impatient author with type θ and history $\tilde{h}$ is indifferent between A and B ($vPr[s > s_A|\theta, \tilde{h}] = Pr[s > s_B|\theta, \tilde{h}]$), then for a patient author, submitting to a class-A journal yields a higher payoff than to a class-B one. Under such situation, class-A journals will raise their thresholds because they receive a paper having been probably rejected more times.

4.2. Equilibrium Multiplicity

There could be multiple equilibria when the number of journals is finite. To better illustrate the intuition, I use the simplified case. Consider two journals A and B with different standards of qualities $q_A > q_B$. There is no submission fee ($c \to 0$), and a publication in either journal yields the same payoff to the author ($v \to 1$). Under this setting, one need not compute the author's cutoff strategy θ^* but consider her submission order. This simplified case could be extended generally, which is discussed in section 5.

One apparent equilibrium is that journal A sets a higher threshold than journal B ($s_A > s_B$) since the former has a higher standard. Then, the author submits her paper to journal B at first whatever her type, because it is more likely to be accepted with a lower threshold. After getting rejected, she submits it to journal A.

When q_B is close to q_A, however, an opposite equilibrium also exists. The author submits her paper to journal A at first whatever her type. Getting rejected, she submits it to journal B. In this case, journal B's threshold s_B is higher than s_A because it receives papers that have been rejected by A and are possibly of bad quality. The second equilibrium seems counterintuitive because the lower-standard journal sets a higher threshold of acceptance.

Proposition 6. *There exists a Δ such that when $q_B \in (q_A - \Delta, q_A)$, two equilibria exist:*

1. *the author submits her paper to journal B at first, and $s_A^* > s_B^*$;*
2. *the author submits her paper to journal A at first, and $s_A^* < s_B^*$.*

Proof: refer to Appendix D. ||

Which equilibrium is selected depends on which journal exists at first. If journal B exists at first, the author submits her paper to it. Then, journal A is established and gets the rejected paper. It sets a higher threshold not only because of its higher standard but also because it receives papers of bad quality. In contrast, if journal A exists at first, and then journal B is established. The latter sets a higher threshold even though its standard is lower. This reasoning provides an innovative insight for the entry barrier in such markets, where the entrant should set an unfairly high threshold to compete with the incumbent.

5. Entry Barrier

In this section, I use a dynamic model to give some qualitative results of the entry barrier. I find that the entrant is not able to compete head-on with the incumbent if it can't bring a much higher value without mutation of authors' submission order. Then, I analyze how authors' and journals' noisy perception of quality strengthens the entry barrier, and the barrier still exists if journals set the capacity instead of the standard of quality. Finally, I find the condition such that the entry barrier exists in the long run.

Consider an incumbent journal of which the standard is $q_I = 0$, and the payoff of a publication is normalized to 1. Suppose there are N authors, and in each period $t = 1, 2, ...$, each author has one paper in hand to submit. To simplify the model, I assume that there is no submission cost, authors wish to get published as soon as possible, and they know nothing but the prior distribution $f(q)$ about the quality. The incumbent sets the threshold $s_I(t)$ and publishes papers of which signals are higher than the threshold.

Then, in period t', an entrant issues a new journal. It needs to set its standard q_E to compete with the incumbent. The payoff of a publication on the entrant's journal is contingent on q_E, denoted as $v_E = g(q_E)$. g is assumed to be increasing in q_E, $g(q_E) < 1$ if $q_E < 0$, and $g(q_E) > 1$ if $q_E > 0$. In this period, it only receives papers rejected by the incumbent previously, and it sets the threshold $s_E(t')$ and publishes papers of which signals are higher than the threshold.

From period $t \geq t' + 1$, two journals compete for authors (qualified papers), given not only their payoffs from publication v_I and v_E but also their thresholds $s_I(t)$ and $s_E(t)$. The author follows a *deterministic dynamic* of choosing which journal to submit at first. Specifically, she computes the expected payoffs from submitting her paper to the incumbent or the entrant based on the previous period. In period t, she submits her paper to the entrant if $\pi_I(t) \leq \pi_E(t)$

$$v_I \int f(q)\big[1 - \Phi\big(s_I(t-1), q, \sigma_s\big)\big]dq < v_E \int f(q)\big[1 - \Phi\big(s_E(t-1), q, \sigma_s\big)\big]dq$$

Otherwise, she chooses the incumbent at first. If she gets rejected, she tries the other journal.

The following proposition shows that unless the entrant brings an extremely high value, it becomes the authors' first option. Otherwise, it only receives papers rejected by the incumbent and has no chance to shake the latter's status.[1]

[1] This result is robust to the case in which the entrant can change its standard of quality at any time. Specifically, if the entrant's value is always below the upper bound at any q_E, whenever it changes q_E, the incumbent is still the authors' first option.

Proposition 7. *There exists an upper bound $\bar{v}_E$ of g such that if $g(q_E) < \bar{v}_E(q_E)$, authors always submit their papers to the incumbent at first whatever standard the entrant sets. And,*

1. *$\bar{v}_E$ is increasing in q_E.*
2. *There is a $\underline{q} < 0$ such that $\bar{v}_E(q_E) > 1$ if and only if $q_E > \underline{q}$.*
3. *If $\underline{q} < q_E < 0$, then $s_I(t) < s_E(t)$ for any $t > t'$.*

Proof: refer to Appendix D. ||

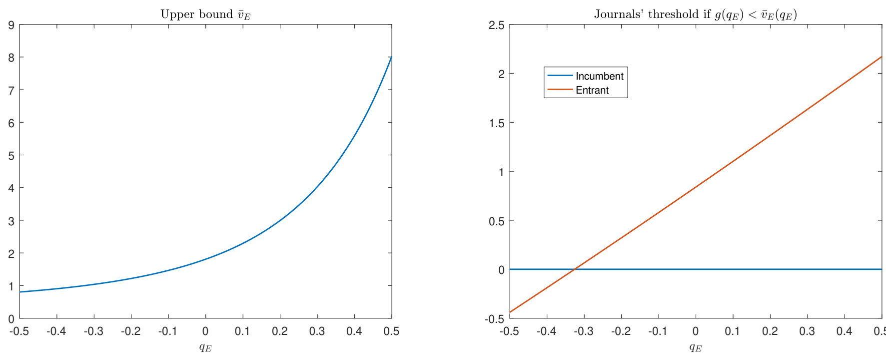

Fig. 5. The left graph is the upper bound $\bar{v}_E$ of the entrant. The right graph is the journals' threshold when the entrant's value is lower than the upper bound. The quality follows a normal distribution: $f(q) = \phi(q, 0, \sigma_q)$. The parameters are: $\sigma_q = \sigma_s = 1$.

Undercutting is never optimal

First, it is not a good strategy that the entrant undercuts the incumbent by setting a slightly lower standard of quality ($\underline{q} < q_E < 0$). The purpose of doing so is to increase the probability of acceptance so that authors will submit to the entrant at first. However, it fails because it leads to the counterintuitive equilibrium discussed in the previous section. The convention is to submit to the incumbent at first. Then, because the entrant receives papers rejected by the incumbent and their qualities are more likely to be low, it sets a higher threshold (as shown in the right graph of figure 5) even though its standard is lower. As a result, the entrant brings a lower payoff $v_E < 1$ but has a higher threshold. It further intensifies the convention.

Setting a higher standard

Secondly, the entrant is not able to compete with the incumbent by setting a higher standard if v_E is not high enough. More precisely, even though the entrant brings a higher value from publication than the incumbent, it has to set an unfairly high threshold (as shown in the right graph of figure 5) if authors follow the convention of submitting to the incumbent at first. Again, in reverse, it intensifies the convention. As a result, although the entrant publishes high-quality papers, the amount is low due to the high threshold.

Avoiding competition

Finally, as the entrant lowers its standard of quality significantly, its threshold becomes lower than the incumbent's and it publishes more papers. However, many of them are of bad quality. It still does not shake the status of the incumbent.

5.1. Impact of Noisy Perception

The key factor to generate entry barriers is the information asymmetry between authors and journals. It stems from their noisy perceptions of quality and journals' ignorance about authors' submission histories. The following analysis shows how perfect perception of either side reduces the barrier.

Impact of Journals' Perception of Quality

Journals observing the quality perfectly ($s = q$ or $\sigma_s = 0$), authors' histories are irrelevant and there is no information asymmetry. The entrant does not need to correct selection bias by setting an unfairly high threshold. The author coming at time t submits her paper to the entrant if

$$v_I[1 - F(q_I)] < v_E[1 - F(q_E)]$$

Figure 6 shows that the upper bound $\bar{v}_E$ is much lower compared to the case in which journals only have noisy signals of the quality. Without setting an unfairly high threshold, the entrant becomes the first option for authors if it sets a higher standard of quality and brings a reasonably high payoff. In other words, there is no entry barrier.

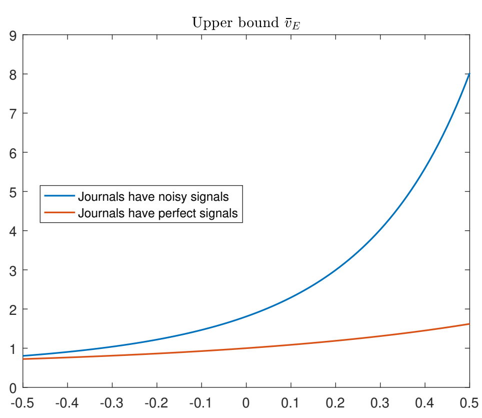

Fig. 6. The quality follows a normal distribution: $f(q) = \phi(q, 0, \sigma_q)$. The parameters are: $\sigma_q = \sigma_s = 1$.

Impact of Author's Perception of Quality

I analyze how the entry barrier is reduced by the author's perfect perception of quality. In opposite to coarse authors discussed previously, consider the sophisticated authors who can perceive the quality perfectly.

With two journals having different standards and payoffs from publication, the market of sophisticated authors splits if journals' thresholds are not inverted.[2] Those with good-quality papers pursue the journal bringing higher payoff no matter it is the incumbent or the entrant, while the rest choose the one with a higher probability of acceptance. Thus, the following proposition shows that the entrant can always be the first option of some sophisticated authors unless it tries to undercut the incumbent.

Proposition 8. *If the entrant sets the standard of quality q_E and its corresponding payoff is v_E, then,*

1. *If $q_E > 0$, there is a cutoff $\tilde{q}(q_E, v_E)$ such that the sophisticated author whose paper's quality $q > \tilde{q}(q_E, v_E)$ chooses the entrant at first. Otherwise, she chooses the incumbent.*
2. *If $\underline{q} \leq q_E \leq 0$, the sophisticated author chooses the incumbent at first whatever the quality of her paper. $\underline{q}$ is defined in the same way as in proposition 7.*
3. *If $q_E < \underline{q}$, there is a cutoff $\tilde{q}(q_E, v_E)$ such that the sophisticated author whose paper's quality $q > \tilde{q}(q_E, v_E)$ chooses the incumbent at first. Otherwise, she chooses the entrant.*

Proof: refer to Appendix D. ||

5.2. Competing with Fixed Capacity

In the previous analysis, I assume that journals set the standard of quality. However, sometimes they do not have this choice but publish the best ones among what they receive under a fixed capacity. In this section, I use a dynamic model to characterize the competition between the incumbent and the entrant.

I keep the settings from the previous analysis, but I assume now journals set the capacity of publishing. The incumbent's capacity is fixed at some $r_I < N$, which means it can publish at most r_I number of papers in any period. It ranks papers according to their corresponding signals and publishes the best ones. Denote the marginal signal as $s_I(t)$. Compared to the previous case, the incumbent is not strategic. It does not need to form the belief of the author's history but accepts papers with signals higher than $s_I(t)$. The payoff from publication $v\big(\bar{q}(t)\big)$ is a function contingent on $\bar{q}(t)$, the average quality of the papers published on the journal in period t. Normalize $v\big(\bar{q}_I(1)\big)$ to 1.

[2] Similar result can be found in Hvide et al. [2009].

Then, in period t', the entrant journal is established. It first decides its capacity r_E. At this time, it only receives papers rejected by the incumbent and publishes the best ones among them. The marginal signal is $s_E(t')$.

From period $t \geq t'+1$, two journals compete for authors given not only their payoffs from publication $v\big(\bar{q}_I(t)\big)$ and $v\big(\bar{q}_E(t)\big)$ but also their acceptance rates. The author computes the expected payoffs from submitting her paper to the incumbent or the entrant,

$$\pi_I(t) = v\big(\bar{q}_I(t-1)\big) \int f(q)\big[1 - \Phi\big(s_I(t-1), q, \sigma_s\big)\big] dq$$

and

$$\pi_E(t) = v\big(\bar{q}_E(t-1)\big) \int f(q)\big[1 - \Phi\big(s_E(t-1), q, \sigma_s\big)\big] dq$$

By comparing these payoffs, the author chooses one journal. Getting rejected, she tries the other one.

Similarly to proposition 7, one can find that the entry barrier also exists if the entrant can not bring a much higher value.

Corollary 1. *There exists an upper bound $\bar{v}$ of v such that if $v(\bar{q}) < \bar{v}(\bar{q})$, authors always submit their papers to the incumbent at first whatever capacity the entrant sets.*

Intuitively, choosing a small capacity is equivalent to setting a high standard of quality, and vice versa. The existence of the entry barrier with journals setting capacities is coincident with the case where journals set the standard of quality.

5.3. Entry Barrier in the Long Run

In the previous analysis, I let authors follow the deterministic dynamic when deciding which journal to submit at first. In this section, I introduce "mutation". I assume there is some probability that the old authors pass away. Not being familiar with the payoffs from submitting, the new coming authors just randomly choose one journal. Then, the question is "Does entry barriers still exist for the entrant in the long run?" The answer is it reduces compared to the without mutation case, but when the number of authors is large, it takes an extremely long time for the entrant to transcend it.

Specifically, Let z_t be the number of authors who choose to submit to the incumbent at first in period t. The deterministic dynamic[3] for the authors is

$$z_t = b(z_{t-1}) = \begin{cases} N & if\ \pi_I(t) \geq \pi_E(t), \\ 0 & otherwise \end{cases}$$

Now, assume that in each period, with probability ϵ, each author changes her submission order, which is the mutation. Then, I define the long run equilibrium according to definitions 1 and 2 in Kandori et al. [1993]. First, one has a stochastic process of z_t,

$$z_t = b(z_{t-1}) + x_t - y_t$$

where x_t and y_t are binomial distributions,

$$x_t \sim Bin(N - b(z_{t-1}), \epsilon),\ y_t \sim Bin(b(z_{t-1}), \epsilon)$$

Then, one gets a Markov chain of z_t. Let P be the Markov matrix, in which the element

$$p_{ij} = Pr[z_{t+1} = j | z_t = i]$$

Let $\mu_\epsilon = \big(\mu_\epsilon(1), \mu_\epsilon(2), ..., \mu_\epsilon(N)\big)$ be the stationary distribution of z_t, which is $\mu_\epsilon P = \mu_\epsilon$.

Definition 1. *Denote the limit distribution*

$$\mu^* = \lim_{\epsilon \to 0} \mu_\epsilon.$$

Always submitting to the incumbent (entrant) at first is the long run equilibrium if $\mu^*(N) = 1$ ($\mu^*(0) = 1$).

With authors' mutations, it can fall into the equilibrium that the entrant favours as time goes. The following proposition shows that when the entrant's value is large enough, this equilibrium is stable. Moreover, this upper bound is lower than that of the without mutation case, also shown in figure 7. It means that the entrant's barrier becomes lower in the long run.

Proposition 9. *There exists an upper bound $\hat{v}_E$ of g such that if $g(q_E) \leq \hat{v}_E(q_E)$, always submitting to the incumbent at first is the long run equilibrium. Otherwise, always submitting to the entrant is. And, $\hat{v}_E(q_E) < \bar{v}_E(q_E)$.*

[3]This deterministic dynamic can be generalized to any one satisfying: $sign\{b(z_{t-1}) - z_{t-1}\} = sign\{\pi_I(t) - \pi_E(t)\}$

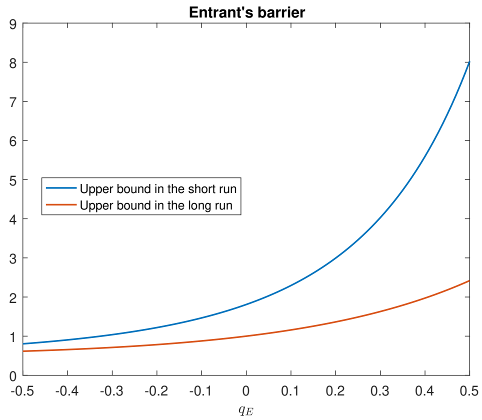

Fig. 7. The quality follows a normal distribution: $f(q) = \phi(q, 0, \sigma_q)$. The parameters are: $\sigma_q = \sigma_s = 1$.

Proof: refer to Appendix D. ||

How "long" does it need to transit to the long run equilibrium?

It requires some proportion of authors to mutate to transit from the status quo to another equilibrium. First, a higher value v_E requires fewer mutations. Thus, the time needed to change the status quo is shorter. Another factor is the number of authors. With more authors, it asks for more mutations to reach the turning proportion. Therefore, it becomes longer to transit from the status quo.

Consider an example with $q_E = 0.1$ and $\epsilon = 0.1$. Table 1 shows the expected periods for transition to the equilibrium favouring the entrant under some bundles of parameters. It shows that when the number of authors is large, the entrant needs to wait billions of periods to become their first option.

N	v_E	T		N	v_E	T
20	1.1	2.5×10^8		4	1.5	19.1
20	1.2	1.4×10^6		10	1.5	78.2
20	1.3	1.7×10^4		20	1.5	88.9
20	1.4	419		30	1.5	128
20	1.5	88.9		50	1.5	311
20	1.6	23.2		80	1.5	3.6×10^3
20	1.7	7.52		150	1.5	2.3×10^5
20	1.8	3.10		300	1.5	3.3×10^9

Table 1: N: number of authors, v_E: entrant's value, T: expected periods for transition to the equilibrium favouring the entrant.

6. Conclusion and Further Discussion

The model in this paper investigates an academic publishing problem with information asymmetry and dynamic learning. First, I find that without knowing the quality of papers perfectly, high-type authors try more submission compared to low-type ones. In contrast, knowing it perfectly, they will always try. Secondly, I find that there are multiple equilibria with two classes of journals, which triggers the existence of the entry barrier. It shows that the entrant can not compete with the incumbent for both the market share and high-type authors. Moreover, authors' and journals' noisy perception of quality will make the entry barrier higher.

The model can be extended to broader applications. One is the credit rating agencies that give a rating of security's default risk after issuers contact them. The issuer could disclose the rating if he is satisfied, or find other agencies until he is satisfied. Again, agencies face selection bias which means the coming issuer could receive a bad rating before. The major difference with the current model is now the agency needs to make a more complicated decision rather than acceptance or rejection.

The "Big Three" credit rating agencies (Moody's, Standard & Poor's, and Fitch) control approximately 95% of the rating business since the 1990s (Cantor and Packer [1995]). These firms form an oligopoly in the credit rating market. Bolton et al. [2012] attributes it to the regulation. Bar-Isaac and Shapiro [2011] attributes it to the labour shortage. It is hard to explain why the initial big three defeat all other later-coming 7 firms, however. Applying the result in this paper, intuitively entry barriers exist in this market because most of the entrant's clients are those who are not satisfied with the rating from the incumbents. If the former maintains prudent, still issuers will not be satisfied, so that its market share will be low. If it tries to ingratiate itself with issuers, it loses its credit in this market.

The existence of entry barriers found in this paper has some inspiration in policymaking. The key factor to generate the barriers is the noisy perception. Therefore, one direction of reducing the barriers is to implement accurate perceiving technology. Another direction of breaking the vicious cycle is to change the convention radically. One example is the draft lottery system in the North American sports league. It leads high-potential rookies to go to weak teams so that the oligopoly becomes harder to form.

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Appendix A. Author's Noisy Perception

In section 3.3, I find that knowing the quality perfectly, the author always submits her paper until she gets a publication or there is no chance left if the quality is sufficiently high. In contrast, she learns after each submission, and the high-type author tries more times and stops after several submissions. In this section, I analyze how this ignorance affects the agents' behavior.

Consider a case where the author's type θ follows a normal distribution: $\mu(\theta) = \phi(\theta, 0, \sigma_\theta)$. The quality follows a normal distribution conditional on θ: $f(q|\theta) = \phi(q, \theta, \sigma_q)$. σ_q is a measure of the author's ignorance level. There are two homogeneous journals A in the field, which yields v to the author for the publication. The submission cost is c. Their standard of quality q_A is 0. The journal observes a noisy signal conditional on the quality $s = q + \epsilon$, $\epsilon \sim \mathcal{N}(0, \sigma_s)$.

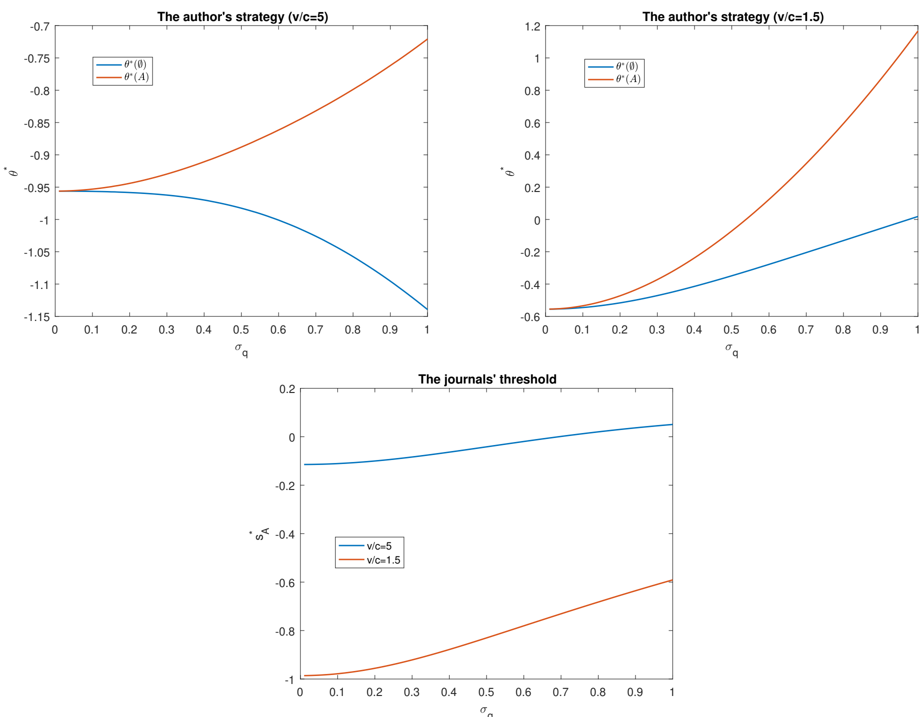

Fig. 8. The left graph is the acceptance rate of a paper with quality q. The right graph is the author's payoff if the quality is q.

When σ_q is close to 0, the author has a precise perception of quality. What I find in section 3.3 indicates $\theta^*(\emptyset)$ are close to $\theta^*(A)$. As σ_q increases, the author with a relatively lower type stops after getting a rejection. As shown in figure 8, the difference between $\theta^*(A)$ and $\theta^*(\emptyset)$ becomes larger. Another finding is the trend of $\theta^*(\emptyset)$ depends on the benefit-cost ratio (v/c). When the author is extremely ignorant, her type implies little information. If

v/c is high, the ignorant author without getting rejected wants to try whatever her type. Thus, $\theta^*(\emptyset)$ decreases as σ_q increases. In contrast, if v/c is low, the ignorant author has less willing to have a try.

From the journals' side, as the author becomes ignorant, they are more likely to receive papers of low quality. Thus, they raise their thresholds.

Appendix B. Market Differentiation

In section 4, I present the idea that introducing an ordinary class of journals splits the market of authors, makes the top-class journals easy to select those papers with high quality, and thus is beneficial to efficiency. In this section, I will further discuss it by analyzing the situation of two journals with three cases: 1. both set a low standard of quality; 2. both set a high standard of quality; 3. one set a high standard, and the other set a low one.

More specifically, consider a case where the author's type θ follows a normal distribution: $\mu(\theta) = \phi(\theta, 0, 1)$. The quality follows a normal distribution conditional on θ: $f(q|\theta) = \phi(q, \theta, 1)$. Assume that the paper with a quality $q > 0$ is valuable and should be published. A paper with higher quality is more valuable. There are two journals A and B in the field. The submission cost is $c = 0.1$. The journal observes a noisy signal conditional on the quality $s = q + \epsilon$, $\epsilon \sim \mathcal{N}(0, 1)$. In case 1, both set a baseline standard of quality $q_A = q_B = 0$. A publication on either of them yields 1 to the author. In case 2, both set an aggressive standard $q_A = q_B = 1$. A publication on either of them yields 2. In case 3, journal A sets $q_A = 1$ while journal B sets $q_A = 0$. A publication on journal A yields 2, and 1 on journal B.

I define efficiency in two aspects: one is whether the paper published is worthwhile. I use the following W_1 to measure the global quality of the papers in the market.

$$W_1 = \mathbb{E}[q; Accepted] = \int_{-\infty}^{+\infty} q\phi(q, 0, 2) Pr[Accepted|q] dq$$

A higher W_1 means the market generates more valuable knowledge. The other aspect is whether a high-quality paper is easier to be published in a journal bringing higher payoff, and a relatively low-quality paper is easier to be published in a journal bringing lower payoff.

First, I solve the equilibrium in these 3 cases.

Case 1

The author with a type $\theta > -1.65$ submits her paper to either journal at first. If she gets rejected, she submits to the other journal if her type $\theta > -1.39$. Both journals set the threshold $s_A = s_B = 0.16$.

Case 2

The author with a type $\theta > -0.75$ submits her paper to either journal at first. If she gets rejected, she submits to the other journal if her type $\theta > -0.58$. Both journals set the threshold $s_A = s_B = 1.58$.

Case 3

The author with a type $\theta > 0.71$ submits her paper to journal A at first. If she gets rejected, she submits to journal B. The author with a type $\theta \in (-1.73, 0.71)$ submits her paper to journal B at first. If she gets rejected, she submits to journal A if her type $\theta > -0.42$. Journal A sets the threshold $s_A = 1.31$ while journal B sets $s_B = 0.08$.

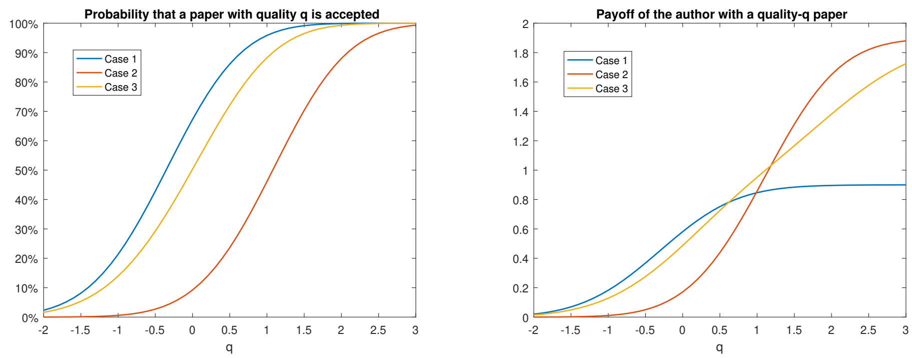

Fig. 9. The left graph is the acceptance rate of a paper with quality q. The right graph is the author's payoff if the quality is q.

Secondly, I analyze market efficiency in two aspects mentioned. From the first aspect, I compute the value of W_1 under three cases: 0.4788, 0.3948, and 0.4786. The first and third cases generate a similar amount of knowledge. In the first case, more papers are published and some of them are of low quality, compared to the second case. This is because journal A has a higher standard of quality in case 3. The left graph in figure 9 also shows that the yellow curve is slightly below the blue one since journal A accepts fewer papers but with higher quality. In case 2, W_1 is lower because of the fact that far fewer papers are published. This is not only because journal B has a high standard but also because journals should set higher thresholds to correct selection bias. The right graph shows the author's payoff if the quality is q. In case 1, the author with a high-quality paper does not get rewarded while in case 2, only the substantial-high-quality paper brings a reward. In case 3, the extreme situation is improved by splitting the authors.

From the second aspect, in case 3, journal A's threshold s_A is lower compared to case 2, and journal B's threshold s_B is lower compared to case 1. The authors find it easier to publish either a high-quality or a relatively low-quality paper in the corresponding journal. Still, it is because of the splitting which weakens selection bias.

Appendix C. Author Knows Her Type

Section 5 presents that when authors are totally ignorant about the quality ex ante, entry barriers exist. In this section, I generalize this result by letting the author know her type as defined in section 2. It is a partial information about the quality. Now, the author with type θ in period t submits her paper to the incumbent if

$$v_I \int f(q|\theta)\big[1 - \Phi\big(s_I(t-1), q, \sigma_s\big)\big]dq \geq v_E \int f(q|\theta)\big[1 - \Phi\big(s_E(t-1), q, \sigma_s\big)\big]dq$$

Undercutting is not optimal

First, similarly to proposition 7, one can find that undercutting is not a good strategy. There is a $\underline{q}$ such that when $q_E \in (\underline{q}, q_I)$, in equilibrium, $s_I(t) < s_E(t)$ for any $t > t'$ and the incumbent is the author's first option whatever her type.

Setting a higher standard is not optimal

Secondly, the entrant is not able to compete with the incumbent by setting a higher standard if v_E is not high enough. More precisely, consider the author's behavior under different v_E given the entrant's standard. The curves in figure 10 represent the author's cutoff type. If her type is higher than the curve, she chooses the entrant as the first option because it brings a higher payoff from publication $v_E > 1$. The blue curve is corresponding to the real case that the entrant is established after the incumbent, the red one being the counterfactual and reversed case that the entrant exists at first.

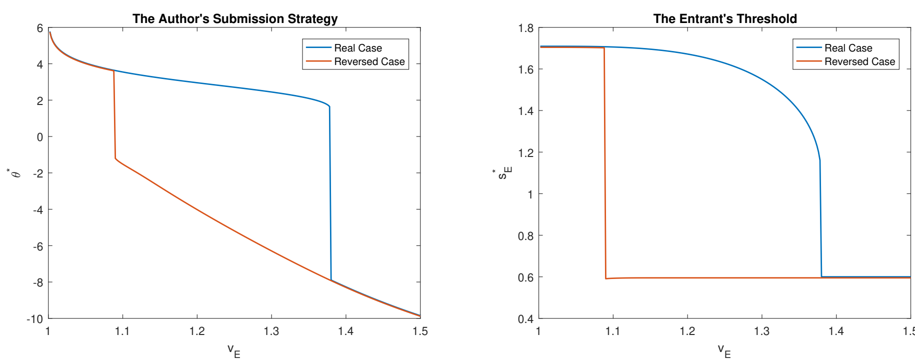

Fig. 10. The type θ follows a normal distribution: $\mu(\theta) = \phi(\theta, 0, \sigma_\theta)$. The quality follows a normal distribution conditional on θ: $f(q|\theta) = \phi(q, \theta, \sigma_q)$. The parameters are: $\sigma_\theta = \sigma_q = \sigma_s = 1$. $q_E = 0.4$.

In the real case, only after v_E reaches 1.38, the entrant becomes the first option of most authors. However, if it exists at first, v_E only needs to be higher than 1.1 to keep its market share. When v_E is lower than 1.38, the incumbent gains from the convention of submission order, as the entrant has to set an unfairly high threshold as shown in the right graph. It again disables the entrant to compete with the incumbent.

The only option left is avoiding competition

Figure 11 illustrates a specific example. Before the entrant journal is established, the authors have only one option. All of them submit their paper to the incumbent. If the entrant sets a higher standard of quality ($q_E > q_I = 0$), the incumbent is still the first option for almost all authors, as shown in the top-left graph. It needs to set an unfairly high threshold to select the good ones (even if q_E is close to 0, the entrant's threshold s_E^* is much higher than s_I^*), as shown in the top-right graph. The situation does not improve as the entrant sets a slightly lower standard ($q_E < q_I$). The author always submits to the incumbent at first whatever her type because of the inverted thresholds. The thresholds are not inverted until the standard decreases significantly to around -0.4. The entrant becomes the first option of some authors.

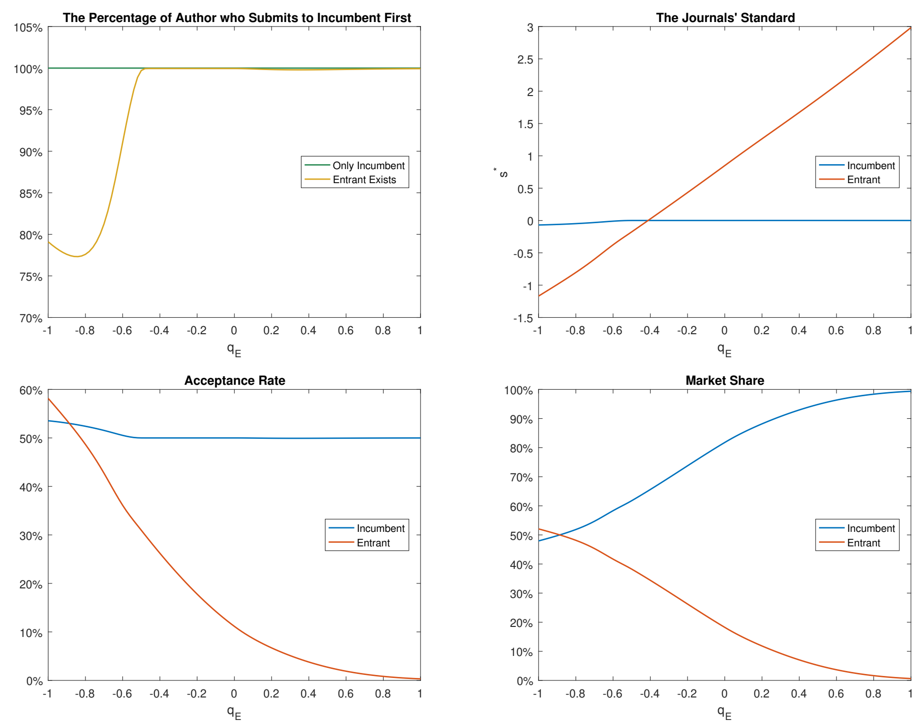

Fig. 11. The top-left graph is the proportion of the author who submits to the incumbent first before and after the entrant journal is established. The top-right graph is journals' strategy of thresholds. The bottom-left graph is journals' acceptance rate. The bottom-right graph is journals' market share. The type θ follows a normal distribution: $\mu(\theta) = \phi(\theta, 0, \sigma_\theta)$. The quality follows a normal distribution conditional on θ: $f(q|\theta) = \phi(q, \theta, \sigma_q)$. The parameters are: $\sigma_\theta = \sigma_q = \sigma_s = 1$ and $v_E = g(q_E) = 1 + q_E/2$.

The bottom two graphs illustrate the market share of these two journals. The incumbent accepts around 50% of all papers it receives. Setting a higher standard ($q_E > 0$), the entrant just accepts less than 10% of all papers because most of them have been rejected by the incumbent. Its market share is much lower than the incumbent. It increases, however, as the entrant lowers its standard of quality significantly. It publishes more papers, but many of them are of low quality. It still does not shake up the status of the incumbent.

Appendix D. Proofs

Proof of proposition 2:

If $m = 1$, one can find s_A^* and $\theta_A^*(\emptyset)$. Then, if $m = 2$, one consider the expected quality if journals keep the standard at s_A^*.

$$\frac{\int_{-\infty}^{+\infty} q \int_{\theta_A^*(A)}^{+\infty} f(q|\theta, A) d\theta dq}{\int_{-\infty}^{+\infty} \int_{\theta_A^*(A)}^{+\infty} f(q|\theta, A) d\theta dq}, \ \textit{where } f(q|\theta, A) \propto f(q|\theta)\Phi(s_A^*, q, \sigma_s)$$

If $c \to 0$, $\theta_A^*(A) \to -\infty$. Along with $f(q|\theta, \emptyset)$ first-order stochastic dominating $f(q|\theta, A)$, the expected quality must be lower than q_A if $c \to 0$. Thus, one can find $\underline{c}_1 \in (0, v]$ such that the expected quality is higher than q_A.

Then, for $m > 2$, one repeats above process to find $\underline{c}_{m-1}$. $\underline{c} = \inf_{1 \le i \le m-1} \underline{c}_i$. ■

Proof of proposition 3:

$\int_{-\infty}^{+\infty} f(q|\theta_A^*(h), h)[1 - \Phi(s_A, q, \sigma_s)]dq = c/v$ and the left hand side is increasing in $\theta_A^*(h)$. So, as v/c increases, $\theta_A^*(h)$ decreases. It lowers the paper's expected quality. Thus, to make it equal to q_A, journals raise the threshold. ■

Proof of proposition 4: According to lemma 2, given s_A, q^* is well-defined by

$$v[1 - \Phi(s_A, q^*, \sigma_s)] = c,$$

and continuous in s_A. Then, the journal receiving a paper forms a belief β_A based on (3). According to lemma 1, the journal could find the optimal threshold noted as $\xi(s_A)$. The left hand side of (1) and β_A are continuous in q^*. Therefore, $\xi(s_A)$ is continuous in s_A. Obviously, $\xi(s_A)$ is bounded. As a result, there exists a fixed point $\xi(s_A^*) = s_A^*$ according to Brouwer fixed-point theorem.

If $q^* > q_A$, the journal will accept the paper whatever signal it receives since the editor knows its quality is higher than the standard. Then, the author with a paper of which the quality is lower than q^* will also submit it. So, $q^* < q_A$. ■

Proof of lemma 3:

The left hand side of (4) is increasing and continuous in s. Moreover,

$$\lim_{s\to+\infty}\mathbb{E}_f[q|s]=+\infty,\ \lim_{s\to-\infty}\mathbb{E}_f[q|s]=-\infty,\ \forall f\in\mathcal{F}$$

Therefore, there exists a s_A (s_B) such that

$$\sum_{f\in\mathcal{F}}\tilde{\beta}_A(f)\mathbb{E}_f[q|s_A]=q_A,\ \sum_{f\in\mathcal{F}}\tilde{\beta}_B(f)\mathbb{E}_f[q|s_B]=q_B.\ \blacksquare$$

Proof of lemma 4:

Since $f(q|\theta,\tilde{h})$ satisfies the MLRP, $\pi_A(\theta,\tilde{h})$ is monotonically increasing. Along with

$$\lim_{\theta\to+\infty}\pi_A(\theta,\tilde{h})=v-c>0,\ \lim_{\theta\to-\infty}\pi_A(\theta,\tilde{h})=-c<0,$$

there exists a unique $\theta_A^*(\tilde{h})$ such that $\pi_A(\theta_A^*(\tilde{h}),\tilde{h})=0$. Similarly, a unique $\theta_B^*(\tilde{h})$ exists such that $\pi_B(\theta_B^*(\tilde{h}),\tilde{h})=0$.

$\frac{v\phi(s_A,q,\sigma_s)}{\phi(s_B,q,\sigma_s)}$ is monotone in q. Then, the functions $v[1-\Phi(s_A,q,\sigma_s)]$ and $[1-\Phi(s_B,q,\sigma_s)]$ are single crossing. As a result, either $\pi_A(\theta,\tilde{h})$ is always higher than $\pi_B(\theta,\tilde{h})$, which is corresponding to $\theta^*(\tilde{h})=-\infty$, or $\pi_A(\theta,\tilde{h})$ and $\pi_B(\theta,\tilde{h})$ crosses at a $\theta^*(\tilde{h})\in(-\infty,+\infty)$.

Finally, based on the definition of $\theta^*(\tilde{h})$, $\theta_A^*(\tilde{h})$ and $\theta_B^*(\tilde{h})$, there could be only two cases: 1. $\theta^*(\tilde{h})>\theta_A^*(\tilde{h})>\theta_B^*(\tilde{h})$; 2. $\theta^*(\tilde{h})\le\theta_A^*(\tilde{h})\le\theta_B^*(\tilde{h})$. In the first case, when $\theta\ge\theta^*(\tilde{h})$, $\pi_A(\theta,\tilde{h})>0$ and $\pi_A(\theta,\tilde{h})\ge\pi_B(\theta,\tilde{h})$. When $\theta\in[\theta_B^*(\tilde{h}),\theta^*(\tilde{h}))$, $\pi_B(\theta,\tilde{h})\ge 0$ and $\pi_B(\theta,\tilde{h})>\pi_A(\theta,\tilde{h})$. When $\theta<\theta_B^*(\tilde{h})$, $\pi_A(\theta,\tilde{h})<0$ and $\pi_B(\theta,\tilde{h})<0$. In the second case, when $\theta\ge\theta_A^*(\tilde{h})$, $\pi_A(\theta,\tilde{h})\ge 0$ and $\pi_A(\theta,\tilde{h})>\pi_B(\theta,\tilde{h})$. When $\theta<\theta_A^*(\tilde{h})$, $\pi_A(\theta,\tilde{h})<0$ and $\pi_B(\theta,\tilde{h})<0$. $\blacksquare$

Proof of proposition 5:

Proof: According to lemma 2, given s_A and s_B, $\theta_A^*(\tilde{h})$, $\theta_B^*(\tilde{h})$ and $\theta^*(\tilde{h})$ are well-defined and continuous in s_A and s_B since π_A and π_B are continuous in s_A and s_B respectively. Then, the journal receiving a paper forms the believes $\tilde{\beta}_A$ and $\tilde{\beta}_B$ based on Bayes' rule. According to lemma 3, journals could find the optimal threshold noted as $\xi(s_A,s_B)=(s'_A,s'_B)$. The left hand side of (4) and $\tilde{\beta}_A$ are continuous in $\theta_A^*(\tilde{h})$. Therefore, $\xi(s_A,s_B)$ is continuous in s_A. Similarly, $\xi(s_A,s_B)$ is continuous in s_B. Obviously, $\xi(s_A,s_B)$ is bounded. As a result, there exists a fixed point $\xi(s_A^*,s_B^*)=(s_A^*,s_B^*)$ according to Brouwer fixed-point theorem. $\blacksquare$

Proof of proposition 6:

Proof: The first case is obvious where

$$s_B^* = \arg_{s_B}\left\{\sum_{f\in\mathcal{F}}\beta_B(f)\mathbb{E}_f[q|s_B] = \int \mu(\theta)\frac{\int qf(q|\theta)\phi(s_B,q,\sigma_s)dq}{\int f(q|\theta)\phi(s_B,q,\sigma_s)dq}d\theta = q_B\right\}$$

$$s_A^* = \arg_{s_A}\left\{\sum_{f\in\mathcal{F}}\beta_A(f)\mathbb{E}_f[q|s_A] = \int \mu(\theta)\frac{\int qf(q|\theta)\Phi(s_B^*,q,\sigma_s)\phi(s_A,q,\sigma_s)dq}{\int f(q|\theta)\Phi(s_B^*,q,\sigma_s)\phi(s_A,q,\sigma_s)dq}d\theta = q_A\right\} > s_B^*$$

Then, $\pi_B(\theta,\emptyset) > \pi_A(\theta,\emptyset)$ which means the author will submit her paper to B first.

For the second case,

$$s_A^* = \arg_{s_A}\left\{\sum_{f\in\mathcal{F}}\beta_A(f)\mathbb{E}_f[q|s_A] = \int \mu(\theta)\frac{\int qf(q|\theta)\phi(s_A,q,\sigma_s)dq}{\int f(q|\theta)\phi(s_A,q,\sigma_s)dq}d\theta = q_A\right\}$$

$$s_B^* = \arg_{s_B}\left\{\sum_{f\in\mathcal{F}}\beta_B(f)\mathbb{E}_f[q|s_B] = \int \mu(\theta)\frac{\int qf(q|\theta)\Phi(s_A^*,q,\sigma_s)\phi(s_B,q,\sigma_s)dq}{\int f(q|\theta)\Phi(s_A^*,q,\sigma_s)\phi(s_B,q,\sigma_s)dq}d\theta = q_B\right\}$$

To ensure that $s_A^* < s_B^*$ ($\pi_B(\theta,\emptyset) < \pi_A(\theta,\emptyset)$), q_B should not be too low. s_B^* is increasing in q_B. Therefore, there is a Δ such that $s_A^* = s_B^*$ when $q_B = q_A - \Delta$. ■

Proof of proposition 7:

Given any s_I and s_E, the expected payoff from submitting her paper to the incumbent and the entrant can be rewritten as

$$\pi_I(\emptyset) = \int f(q)[1-\Phi(s_I,q,\sigma_s)]dq$$

and

$$\pi_E(\emptyset) = v_E\int f(q)[1-\Phi(s_E,q,\sigma_s)]dq$$

When

$$v_E > \frac{\int f(q)[1-\Phi(s_I,q,\sigma_s)]dq}{\int f(q)[1-\Phi(s_E,q,\sigma_s)]dq}$$

$\pi_I(\emptyset)$ is always higher than $\pi_E(\emptyset)$. That determines the upper bound $\bar{v}_E$. Since s_E is increasing in q_E and $\bar{v}_E$ is increasing in s_E, $\bar{v}_E$ is increasing in q_E.

Since $v_E < 1$ when $q_E < q_I$, $\pi_I > \pi_E$ if $s_I < s_E$, in which the incumbent will be first option for the author. If it is the case, s_I and s_E are determined by

$$\frac{\int qf(q)\phi(s_I, q, \sigma_s)dq}{\int f(q)\phi(s_I, q, \sigma_s)dq} = q_I$$

$$\frac{\int qf(q)\Phi(s_I, q, \sigma_s)\phi(s_E, q, \sigma_s)dq}{\int f(q)\Phi(s_I, q, \sigma_s)\phi(s_E, q, \sigma_s)dq} = q_E$$

If $q_E = 0$, $s_E > s_I$. The reason is $f(q)\Phi(s_I, q, \sigma_s)/f(q)$ is decreasing in q. Then, the left hand side of the second equation is lower than the one of the first equation. Moreover, the left hand side of the second equation is increasing with s_E. Therefore, there exists a $\underline{q}$ such that $s_I = s_E$. And if $\underline{q} < q_E < 0$, $s_I < s_E$. Then,

$$\bar{v}_E = \frac{\int f(q)[1 - \Phi(s_I, q, \sigma_s)]dq}{\int f(q)[1 - \Phi(s_E, q, \sigma_s)]dq} > 1$$

■

Proof of proposition 8:

If $q_E > 1$, $s_I < s_E$. Then, for the author with a paper of quality q, the payoffs from submitting to the incumbent and the entrant are

$$\pi_I(q, \emptyset) = 1 - \Phi(s_I, q, \sigma_s)$$

$$\pi_E(q, \emptyset) = v_E[1 - \Phi(s_E, q, \sigma_s)]$$

$\frac{\pi_E(q,\emptyset)}{\pi_I(q,\emptyset)}$ is increasing in q since $s_I < s_E$, and converges to v_E. Since $v_E > 1$, there exists $q(q_E, v_E)$ such that $\pi_E(q(q_E, v_E), \emptyset) = \pi_I(q(q_E, v_E), \emptyset)$, and $\pi_E(q(q_E, v_E), \emptyset) > \pi_I(q(q_E, v_E), \emptyset)$ if $q > q(q_E, v_E)$.

If $q_E < \underline{q}$, $s_I > s_E$ and $v_E < 1$. Then, $\frac{\pi_E(q,\emptyset)}{\pi_I(q,\emptyset)}$ is decreasing in q, and converges to v_E. There exists $q(q_E, v_E)$ such that $\pi_E(q(q_E, v_E), \emptyset) = \pi_I(q(q_E, v_E), \emptyset)$, and $\pi_E(q(q_E, v_E), \emptyset) > \pi_I(q(q_E, v_E), \emptyset)$ if $q < q(q_E, v_E)$.

If $\underline{q} \leq q_E \leq 1$, according to proposition 7, the author submits her paper to the incumbent whatever its quality. ■

Proof of corollary 1:

Follow the same logic of the proof of proposition 7. Given any r_I and r_E, s_I and s_E are defined as

$$\int f(q)\big[1 - \Phi\big(s_I, q, \sigma_s\big)\big]dq = r_I$$

and

$$\int f(q)\Phi\big(s_I, q, \sigma_s\big)\big[1-\Phi\big(s_E, q, \sigma_s\big)\big]dq = r_E$$

Then, one can find the upper bound $\bar{v}(\bar{q})$ of $v(\bar{q})$

$$\bar{v}(\bar{q}) = \frac{\int f(q)[1-\Phi(s_I, q, \sigma_s)]dq}{\int f(q)[1-\Phi(s_E, q, \sigma_s)]dq}$$

where

$$\bar{q} = \frac{\int qf(q)\Phi\big(s_I, q, \sigma_s\big)\big[1-\Phi\big(s_E, q, \sigma_s\big)\big]dq}{\int f(q)\Phi\big(s_I, q, \sigma_s\big)\big[1-\Phi\big(s_E, q, \sigma_s\big)\big]dq}. \blacksquare$$

Proof of proposition 9:

Given theorem 1 in Kandori et al. [1993], always submitting to the entrant at first is the best response if $\pi_I < \pi_E$ under the situation that a half of authors submit to the entrant at first and the other half to the incumbent. If it is the case, $\hat{s}_I$ and $\hat{s}_E$ are determined by

$$\frac{\int q\big[f(q)/2 + f(q)\Phi(\hat{s}_E, q, \sigma_s)/2\big]\phi(\hat{s}_I, q, \sigma_s)dq}{\int \big[f(q)/2 + f(q)\Phi(\hat{s}_E, q, \sigma_s)/2\big]\phi(\hat{s}_I, q, \sigma_s)dq} = q_I$$

$$\frac{\int q\big[f(q)/2 + f(q)\Phi(\hat{s}_I, q, \sigma_s)/2\big]\phi(\hat{s}_E, q, \sigma_s)dq}{\int \big[f(q)/2 + f(q)\Phi(\hat{s}_I, q, \sigma_s)/2\big]\phi(\hat{s}_E, q, \sigma_s)dq} = q_E$$

Then,

$$\hat{v}_E = \frac{\int f(q)[1-\Phi(\hat{s}_I, q, \sigma_s)]dq}{\int f(q)[1-\Phi(\hat{s}_E, q, \sigma_s)]dq}$$

Compared to the thresholds s_I and s_E without mutation, $\hat{s}_I > s_I$ and $\hat{s}_E < s_E$. Therefore, $\hat{v}_E < \bar{v}_E$. $\blacksquare$